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EFFECT OF HYBRID JUTE-COIR FIBRE ON STRENGTH CHARACTERISTICS OF CONCRETE INCORPORATING RICE HUSK ASH

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ABSTRACT

This paper a study has been carried out how to reduce the impact on the environment due to industrial and agricultural waste products such as Rise Husk Ash, Coir fiber and jute fiber which are the waste products of paddy, textile and agricultural industry. Due to pozzolanic reactivity, Rice Husk Ash is used as a supplementary cementing material in concrete, Use of this material in concrete is not only improves strength of concrete but also leads to the proper disposal of these materials, resulting in reducing the impact of these materials on environment. In this research the study of compressive and flexural strength of concrete with replacement of ordinary Portland cement by 10% Rice Husk Ash with the addition of 0.5% and 1.0% of jute fibres, coir fibres and hybrid Jute-coir fibres are studied. Seven concrete mixes M1,M2,M3,M4,M5,M6 and M7 are prepared and compared with that normal concrete mix M1(without RHA and fibre). The results for compressive and flexural strength shows an higher gain in strength for mixes with hybrid fibre as compare to the jute and coir fibre separately. It was observed that 10% of cement replace with RHA and 1.0% hybrid fibre give highest strength value. Workability variation is also studied for different concrete mixes. The addition of hybrid fibre gives slight more variation in the workability as compare to the jute and coir fibre separately. The fibre into fresh concrete can increase the ductility of the concrete and also acts as a crack arrester.

Keywords— Coir fibre, Compressive strength, Flexural strength, Jute fibre, Ordinary Portland Cement, Rice husk ash(RHA).

I. INTRODUCTION

Concrete is a very strong and versatile mouldable construction material. It consists of cement, sand and aggregate (e.g., gravel or crushed rock) mixed with water. The cement and water form a paste or gel which coats the sand and aggregate. Concrete can continue to harden and gain strength over many years. Workability, strength, and durability are three basics properties of concrete. Amount of useful internal work necessary to overcome the internal friction to produce full compaction is termed as Workability. Size, shape, surface texture and grading of aggregates, water-cement ratio, use of admixtures and mix proportion are important factors affecting workability. Strength is to bear the desired stresses within the permissible factor of safety in expected exposure condition. The factor influencing the strength are: quality of cement, water-cement ratio, grading of aggregates, degree of compaction, efficiency of curing, curing temperature, age at the time of testing, impact

and fatigue. Durability is sustenance of shape, size and strength; resistance to exposure conditions, disintegration and wearing under adverse conditions.

II. EXPERIMENTAL PROGRAMME & MATERIALS

To achieve the objectives, an experimental programme was planned to investigate strength properties of concrete containing RHA as partial replacement of cement by 10% with the addition of 0.5%and 1.0% of jute and coir fibre separately and hybrid form. A normal control concrete mix(M1) was used in this analysis. Six concrete mix samples having 10% of RHA and different proprtions of fibre are used in this study. The mixes were designated as M1,M2, M3, M4,M5,M6 and M7 . The experimental study is divided into the following stages:

1) Properties of material used in the study
2) Mix Design
3) Workability of Concrete Mix
4) Compressive Strength of Concrete Mixes
5) Flexural Strength of Concrete Mixes

2.1 Properties of Material used in the study

The test specimens were casted using Cement, Fine aggregate, Coarse aggregate, RHA ,Fibre and water. The materials, in general, confirmed to the specifications laid down in the relevant Indian Standard Codes. The materials used for making concrete have the following properties.

2.1.1 Cement

Ordinary Portland Cement (OPC) of 43 grade was used throughout the investigation. The physical properties of the cement as determined from various tests conforming to Indian Standard IS: 1489-1991 are listed in Table 1.

Table 1. Properties of Cement

Sr. No.	Properties	Observations
1	Fineness (90 micron IS Sieve)	4 percent
2	Initial setting time	50 minutes
3	Final setting time	375 minutes
4	Standard consistency	33 percent
5	Specific Gravity	3.15
6	28-days compressive strength	44.6N/mm^2

2.1.2 Coarse Aggregates

The coarse aggregates used, were obtained from local quarry. The nominal maximum size of coarse aggregate was 12.5mm. Sieve analysis and other physical properties of aggregates are listed in Table 2.

Table 2. Properties of coarse aggregates

Sr. No.	Properties	Observations
1.	Fineness modulus of coarse aggregate	7.36
2.	Specific gravity of coarse aggregate	2.69
3.	Bulk density of coarse aggregate	1720 kg/m^3
4.	Water absorption of coarse aggregate	0.92 %

2.1.3 Fine Aggregate

Natural river sand owing to their rounded shape was used in this work to ensure a better packing characteristic than that of the crushed sand. The grading of sand satisfied the IS: 383-1970.the properties of aggregates are listed in Table 3.

Table 3. Properties of fine aggregates

Sr.No.	Properties	Observations
1.	Fineness modulus of fine aggregate	2.715
2.	Specific gravity of fine aggregate	2.64
3.	Bulk density of fine aggregate	1667 kg/m^3
4.	Water absorption of fine aggregate	0.8 %

2.1.4 Rice husk ash (RHA)

RHA, produced after burning of Rice husk has high reactivity and pozzolanic property. Indian Standard code of practice for plain and reinforced concrete IS 456- 2000, recommends use of RHA in concrete but does not specify quantities. The properties of Rice husk ash are listed in Table 4.

Fig. 1 Rice husk ash (RHA)

Table 4. Properties of Rice husk ash

S No	Property	Value
1	Physical state	Solid-non hazardous
2	Appearance	Very fine powder
3	Particle size	25 microns-mean
4	Colour	Grey
5	Odour	Odourless
6	Specific gravity	2.3

2.1.5 Jute Fibre

Jute is a natural fiber popularly known as the Golden fiber. It is one of the cheapest and the strongest of all natural fibers and considered as fiber of the future. Jute is second only to cotton in world's production of textile fibers. The properties of jute fibre are listed in Table 5.

Fig. 2 Jute fibre

Table 5. Physical Properties of Jute Fibre

	Property	Value
1	Diameter	0.16 to 0.18 mm
2	Length	50-70 mm
3	Colour	Yellow or Brown
4	Specific gravity	1.48

2.1.6 Coir Fibre

Coir fibre used in the project work was also collected from the local market which were cut into small pieces. The properties of coir fibre are listed in Table 6.

Fig. 3 Coir fibre

Table 6. Physical Properties of Coir Fibre:

S No	Property	Value
1	Diameter	0.10 to 0.40 mm
2	Length	50-100 mm
3	Colour	Light brown
4	Specific gravity	1.15

2.1.7 Water

Fresh and clean tap water was used for casting the specimen in present study. The water was relatively free from the organic matter, silt, oil, sugar, chloride and acidic material as per Indian standard.

2.1.8 Super Plasticizer

The super-plasticizer used in the study was Glenium SKY777. Glenium SKY777 is based on second generation poly carboxylic ether polymers and supplied as a light brown liquid instantly dispersible in water.

2.2 Mix Design

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design. Controlled concrete mix of M25 grade was designed as per BIS 10262-2009.the mix proportions are presented in the Table no 7

Details of mix design

Table7 Mix Design Ratio (1: 2.34: 3.17)

Mix Prop	Cement Content	Fine Agg. Content	Coarse Agg. Content	Water
Ratio	1	2.34	3.17	0.45
Kg/m^3	351	822.57	1111.03	157.73

The mix design proportion of Cement, RHA and different fibres are listed in Table 8

Table 8 Detail of Mix Designations

Mix ID	Cementitious content		JuteFibre (%)	Coir Fibre(%)
	Cement OPC - (%)	RHA (%)		
M1	100.0	0	0	0
M2	90	10	0.5	0
M3	90	10	1.0	0
M4	90	10	0	0.5
M5	90	10	0	1.0
M6	90	10	0.25	0.25
M7	90	10	0.5	0.5

2.3 Workability

The property of fresh concrete which is indicated by the amount of useful internal work required to fully compact the concrete without bleeding or segregation in the finished product. The factors affecting workability are water content in the concrete mix , Amount of cement & its properties, aggregate grading (size distribution) , nature of aggregate particles (shape, surface texture, porosity etc.), temperature of the concrete mix , humidity of the environment, mode of compaction, method of placement of concrete, & method of transmission of concrete. the workability is measured in the laboratory by slump test.

2.4 Specimen Details

Cube specimens of size 150mm x 150mm x 150mm were used for obtaining compressive strength of the various mixes , Beams of size 100 mm x 100 mm x 500 mm were used for obtaining the flexural strength.

2.5 Casting And Curing

A suitable control mix was prepared and subsequently mixes containing replaced cement with rice husk ash and fibres as reinforcement in concrete were obtained. The casting of the specimens was done under laboratory conditions using standard equipment. Each batch consisted six standard cubes for determination of 7-days & 28-days compressive strength and three standard beams for determination of 28 days flexural strength. For each batch of concrete mixed, the quantities of various ingredients i.e. cement, rice husk ash, fine aggregate, coarse aggregate, fibre, water, super plasticizer were kept ready in required proportions. Firstly the cement, rice husk ash, fine aggregates and coarse aggregates were mixed thoroughly to get a uniform mix in dry form indicated by the uniform colour and no concentration of either material was visible. Then other ingredients were added in concrete. The concrete mix was filled in the cube and beam specimen and the surface of cubes and

beam was finished.After casting and finishing the surface, the specimens were allowed to harden for 24 hours at room temperature. These were then removed from the moulds and were marked with their respective designations and placed in the curing tank. The cube specimens were removed from water after 7 days and 28-days to obtain the compressive strength and beam specimens were removed from water after 28 days to obtain the flexural strength.

Fig. 4 Finishing the cube moulds

Fig. 5 Finishing the beam moulds

2.6 Tests On Hardened Concrete

To check the hardened properties of concrete the tests conducted are as follows:

a) Compressive Strength Test

b) Flexural strength test

In this report two tests Compressive and Flexural strength were conducted ,in which 7 mix proportions were investigated. Table 9 represents the number of specimens prepared for tests being conducted at each mix proportion. A total of 42 cubes and 21 beams were casted.

Table 9 Shows the details of different types of specimens.

Test	Type of Specimen	Size of Specimen(mm)	Total no. of Specimens
Compressive strength	Cube	150mm x 150mm x150mm	42
Flexural strength	Beam	100mm x 100mm x 500mm	21

Fig.6 Failure of concrete cube

Fig. 7 Failure of concrete beam

III. RESULTS AND DICUSSIONS

3.1 Workability of Concrete Mixes

Workability is considered to be that property of plastic concrete which indicates its ability to be mixed, handled, transported and most importantly, placed with a minimum loss of Homogeneity. More precisely, it defines that it can be fully compacted with minimum energy input. There should be no sign of any segregation or bleeding in a workable concrete. In this experiment slump of all mixes with constant water to cementitious material (w/cm) ratio for the same group were measured to get information about workability changes due to the rice husk ash and fibres. As it is shown below in Table 10 concrete mix with cement substituted by rice husk ash along with the addition of fibres shows reduction in slump value than the control mix. To achieve the required slump Superplasticizer, Glenium SKY777 @0.30%- 0.70% by weight of binder was added to concrete mix.

Table10 Workability Results of all mixes

Mix ID	Cementitious content		JuteFibre(%)	Coir fibre(%)	Slump (mm)
	Cement OPC (%)	Rice Husk Ash (%)			
M1	100.0	0	0	0	102
M2	90	10	0.5	0	98
M3	90	10	1.0	0	95
M4	90	10	0	0.5	97
M5	90	10	0	1.0	95
M6	90	10	0.25	0.25	93
M7	90	10	0.5	0.5	92

3.2 Compressive Strength Test of Concrete Mixes

Mix Name	Cementitious content		Jute fibre (%)	Coir fibre(%)	Failure Load (kN)	7-Days Compressive Strength (N/mm^2)
	Cement OPC (%)	RHA (%)				
M1	100.0	0	0	0	468	20.8
M2	90	10%	0.5	0	515	22.9
M3	90	10%	1.0	0	528	23.5
M4	90	10%	0	0.5	522	23.2
M5	90	10%	0	1.0	537	23.9
M6	90	10%	0.25	0.25	546	24.3
M7	90	10%	0.5	0.5	551	24.5

The results of the compressive strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. These tests were carried out in accordance with IS: 516-1959 on Compression Testing machine. The compressive strength test was conducted at curing ages of 7-days and 28 days. The compressive strength test results of all the mixes and different curing ages are shown in Table-11&12.Variation of compressive strength for different percentage of Jute, Coir and Hybrid fibres at 7-days and 28-days is also shown in Fig 8 and Fig. 9.

Table 11 7 - Days Compressive Strength Values for various Concrete Mix

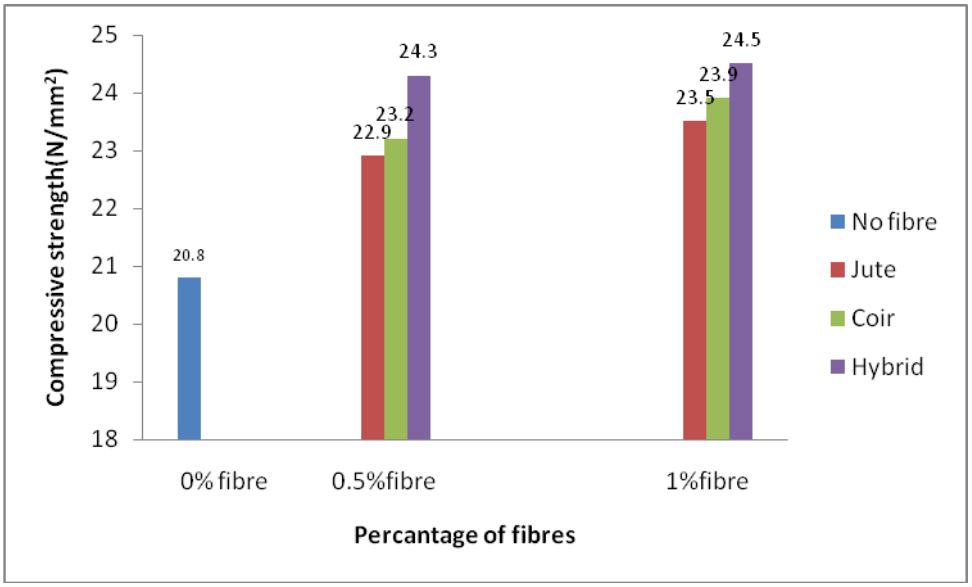

Fig.8 7 Days Compressive Strength for different fibres %age

Table12 28 - Days Compressive Strength Values for various Concrete Mix

Mix Name	Cementitious content		Jute Fibre (%)	Coir Fibre(%)	Failure Load (kN)	28-Days Compressive Strength (N/mm^2)
	Cement OPC (%)	RHA (%)				
M1	100.0	0	0	0	729	32.4
M2	90	10	0.5	0	803	35.7
M3	90	10	1.0	0	819	36.4
M4	90	10	0	0.5	813	36.1
M5	90	10	0	1.0	837	37.2
M6	90	10	0.25	0.25	850	37.8
M7	90	10	0.5	0.5	859	38.2

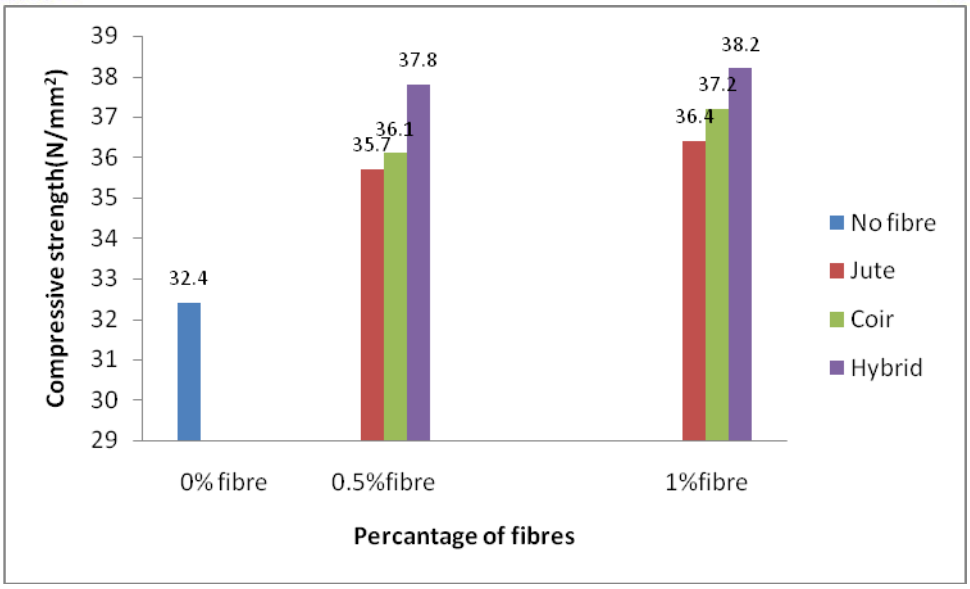

Fig.9 28 Days Compressive Strength for different fibres %age

3.3 Flexural Strength Test of concrete mixes

The results of the flexural strength tests conducted on concrete specimens of different mixes cured at 28 days are presented in Table 13

Table 13. 28 Days flexural Strength Values for various Concrete Mix

Mix Name	Cementitious content		Jute Fibre (%)	Coir fibre(%)	Failure Load (kN)	28-Days flexural Strength (N/mm^2)
	Cement OPC (%)	Rice Husk Ash (%)				
M1	100.0	0	0	0	157	3.14
M2	90	10	0.5	0	170	3.4
M3	90	10	1.0	0	180	3.6
M4	90	10	0.	0.5	176	3.52
M5	90	10	0	1.0	190	3.8
M6	90	10	0.25	0.25	196	3.92
M7	90	10	0.5	0.5	204	4.08

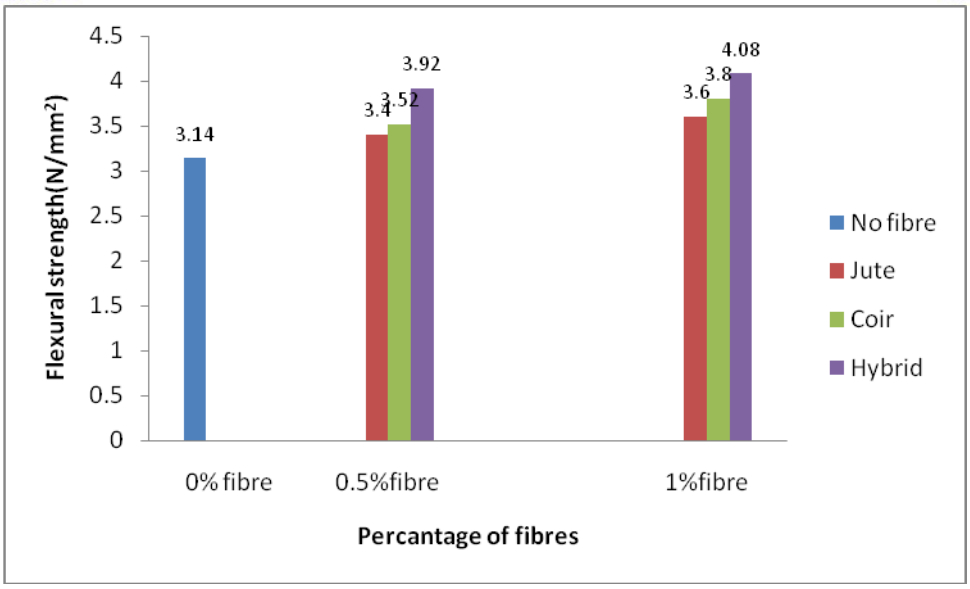

Fig. 10 28 Days flexural strength for different fibres %age

IV. CONCLUSIONS

The present study has investigated the effect of hybrid jute-coir fibre on the workability and strength of concrete mixes. The major conclusions of this study are summarized below:-

1. The workability of all fibre reinforced concrete mixes reduced with the addition of fibres .
2. A slight decrease in the workability was observed in hybridization of two fibres as compare to jute and coir fibre.
3. The partial replacement of cement with rice husk ash at 10% and addition of fibres in concrete mix results in increase of compressive strength as compared to control mix(M1) .
4. Maximum value of compressive strength of concrete mix having RHA replacement of 10% and 1.0% addition of hybrid fibre was 24.5 N/mm^2 for 7 days and 38.2N/mm^2 for 28 days.
5. The maximum gain in the flexural strength was 30 % in reference to control mix (M1), which has been achieved by the mix M7 containing 1.0% hybrid fibre and 10% RHA replace by cement.
6. The addition of hybrid fibres caused a increase in the 28 days compressive strength of concrete i.e.18 % compared to the control mix(M1) .
7. The utilization of RHA not only help the solution for reducing the dump required for waste material but also prove a vital material for the building material as partial replacement of cement a binder material having its own existence.
8. It was observed that concrete involing RHA and fibres does not show sudden failure.
9. It was also noticed that the fibre which is to be used in concrete will be available priceless which will make the concrete economy and as it is natural it will not create any pollution in the environment

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